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ABSTRACT

Surprisingly little work has been done to develop a valid rhetoric of scientific and technical discourse. What little work has been done has not kept pace with the changing needs of scientific and technical disciplines. Research is needed, specifically, on the rhetoric of technology assessment, on visual communication, and on technical manuals. This research should focus on the basic and conceptual issues of rhetoric rather than on the issue that has traditionally preoccupied those involved in technical writing--style. Such research would be a major humanistic contribution in the best tradition of rhetoric. (Author/KS)

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TOWARD A RHETORIC OF SCIENTIFIC AND TECHNICAL DISCOURSE

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Presented to the Modern Language Association
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Surprisingly little work has been done to develop a valid rhetoric of scientific and technical discourse. What little work has been done has not kept pace with the changing needs in scientific and technical disciplines. Research is needed, for example, on the rhetoric of technology assessment, of visual communication, and of technical manuals. This research should focus on the basic and conceptual issues of rhetoric rather than upon the issue that has preoccupied technical writing for so long--style. If such work is done it will be a major humanistic contribution in the best traditions of rhetoric.

It is a commonly accepted fact that the people in scientific and technical disciplines need help with communication. As one of my colleagues, Professor T. M. Sawyer, has pointed out,[1] more than half--56 percent--of the graduates of American colleges and universities each year plan to make careers for themselves in technical and scientific disciplines. Yet the great majority of these graduates have had only one undergraduate course devoted exclusively to instruction in writing--if they have had any at all--and in most instances that course has paid very little attention--if any--to the sort of writing these graduates will do professionally.

Further, the sheer bulk of publication in the sciences and technical disciplines makes it clear that help is needed. For example, Ms. Maurita Holland, Head Librarian in the Engineering Library at The University of Michigan, tells me that there are now more than 30,000 professional and trade journals publishing in English in scientific and technical disciplines. *Chemical Abstracts* alone monitors and abstracts 15,000 journals. Ms. Holland further tells me that our library subscribes to sixty (of the two hundred) journals now devoted exclusively to indexing and abstracting technical publications, that we receive 10,000

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free technical documents from the federal government each year, and that we spend $140,000 per year to keep our purchased collection current. Just to buy the microfiche copies of the materials listed annually by the National Technical Information Service , costs $25,000 per year, and every week in the United States in engineering disciplines alone five new journals are started--at an average subscription cost of $100 each. Small wonder that our library budget is depleted and our shelves full. And small wonder that our colleagues in technical disciplines frequently tell us that communication is the number one problem in scientific and technical areas today.

But the problem with communication in the scientific and technical disciplines is not just that there are a great many people writing in these disciplines or that they collectively produce a great deal of material. Rather the problem is that surprisingly little work has been done to develop a rhetoric of scientific and technical communication, and what little work has been done has not kept pace with the changing and developing needs in scientific and technical disciplines. While the fault for this fact may be partly attributed to the traditionally disdainful attitude of rhetoricians toward what is generally called "technical writing," in large part it is due also to the acceptance of a very limited--and limiting--concept of what they have to contribute by those already working in the area.

My purpose today is two-fold: first I want to suggest some specific areas in which original work on the rhetoric of scientific and technical communication is needed. Second, I want to suggest ways in which this work might be carried out. By doing these two things, I hope to suggest to you, both those of you in technical writing and those of you in traditional English departments, that intellectually exciting and important work is to be done if we are willing to do it.

As an outstanding example of an area in which there is need to develop new rhetorical theory, let me mention first the area of technology assessment.

Although for years people have been worrying and writing about the implications of technical and scientific work, in an official and organized sense the field of technology assessment did not exist until seven years ago. Then, in 1969, the National Environmental Policy Act gave impetus to the development of this field and gave official status to a new type of writing about science and technology, the environmental impact statement. Since that time an astounding number of environmental impact statements and technology assessment reports have been written annually; and the number seems to increase geometrically. For example, counting only those impact statements published by the Federal government,[2] approximately 1000 statements are published each year.

In all, the Federal government has published 7,500 such statements since 1970. The Office of Technology Assessment (OTA) in Washington, an office created by Congress just over three years ago to gather and assess information on scientific and technical projects, has now undertaken 73 assessments for Congress (since early 1974), has 40 assessment projects currently underway, and in 1976 has received 38 new assessment projects from Congress. In 1975, the OTA published fourteen final reports. During this short span of its existence the OTA has employed approximately 900 people in its assessment work. Meanwhile, state governments have been adopting legislation similar to the National Environmental Policy Act and producing impact statements and technology assessments at an even more astounding rate. Fourteen states now do so. California, for example, is publishing 4,000 statements a year.

To me much the most interesting aspect of the development of the field of technology assessment is not in the statistics I have just cited; I cite them merely to indicate both the newness and the magnitude of the problems presented by technology assessment. Rather, to me the interesting thing about technology assessment is how little work has been done in this new area by people in rhetoric or technical communication. On my own campus, for example, of the three courses in technology assessment taught at the university, one is taught by a professor of Electrical Engineering, a second by a professor of Civil Engineering, and a third by a professor from the School of Natural Resources. So far as I can determine no one from rhetoric or technical communication has yet been involved in any of these courses in a direct and important way.[3] Similarly, at the recent Second International Congress on Technology Assessment held in Ann Arbor, of the more than 200 participants from all over the world, only a handful came from primarily humanistic disciplines, and none from English departments. And further, of the very little publication that has been done on the communication aspects of technology assessment writing, virtually none has come from the humanities. Instead, people like Dr. Joseph Coates, OTA Assistant Director, a former chemist, have done what little research and publication has been done on the rhetoric of technology assessment. (Coates has published a short article called "Technology Assessment: A Tool Kit" [*Chemtec*, June 1976]. There is also a "Taxonomy of Technology Studies" done by Ms. Sherry Arnstein and published in *The Proceedings of the 2nd International Congress on Technology Assessment*, October 1976.) As for people in rhetoric and technical communication, it is almost as if this new branch of writing about science and technology did not exist.

If little interest has so far been shown in technology assessment by people in rhetoric or technical communication, however, help is clearly needed. Not only is the assessment procedure itself an appropriate activity for people from the humanities, the only product of technology assessment is a published report; thus the adequacy of the report has everything to do with the success or failure of the assessment activity. Moreover,

the people working in the area are quick to acknowledge that they need help. For example, when participants in the Second International Congress on Technology Assessment were asked what they had to use as guides in writing assessments or in teaching students to do it, their common lament was, "There isn't anything." And they further complained, "Technology Assessments are unreadable!"

It should be apparent, then, that the people in technical communication and rhetoric--the people in this room--would have much to contribute to the field if they were to work on the rhetorical aspects of technology assessment. For example, there is the very fundamental question of audience to be explored. For whom are technology assessments done? What are the implications of those audiences for the assessor/writer? With Congress, lawyers, industrial clients, government agencies, special interest groups, and the general public all reading technology assessment reports, these reports address extremely complex audiences with diverse and even conflicting needs. Yet technology assessors have clearly not sorted out for themselves just who their audiences are or how to address those audiences. In much of the discussion at the Second International Congress on Technology Assessment, the recurrent questions were, "How do I reach and involve the general public?" "How do I balance the public interest over against the interests of my client?" "How do I address the specific concerns of readers interested only in the legal and economic issues, readers interested in technical issues, readers with a special cause to push?" And so on.

Then there is the fundamental issue of problem definition to be explored. Technology assessments not only differ in type but present extremely complex issues, technical, economic, legal, ethical. Yet very little is available to help the assessor/writer to define the problems precisely or to ask the right questions. As Joseph Coates has pointed out, "Early one learns that the client is likely to be unclear as to what the problem is. Thus the initial framing of the problem may require frequent reworking during the study in order to put it in a form to permit decision-related output."[4] In other words, if the problem cannot be defined precisely, the end product of technology assessment--influencing decision-making and policy formulation--cannot be efficiently accomplished. As Coates says, "In my experience, good studies are almost always iterated. You do it once to understand the problem; you do it a second time to get it right; you do it a third time to burnish the results. . . . It may turn out that with experience we can collapse this process into fewer stages, but it's well to plan in at least three stages."[5] I would submit that problem-definition is precisely the sort of activity appropriate to those working in rhetoric and technical communication. Perhaps we could help to collapse those three stages into two; if so, we would have made a major contribution. Of course some work of this sort has already been done in rhetoric,[6] but clearly there remains much to do with the problems peculiar to this new field.

It should be further apparent that people in rhetoric and technical communication should be able to contribute much on issues involving the arrangement of material in technology assessments. With the diverse audiences and purposes they have, technology assessments must be arranged with great skill if they are to be successful. Questions to be explored by those in rhetoric might include: "How can such complex audiences be reached with one document?" "How do you select which information to include?" "How do you arrange key information so that interested parties can find it easily?" "How do you write an instrumentally useful executive summary?" These are all important questions because technology assessments are typically long and extremely complex documents. An extreme example, the Alaska pipeline study made a ten foot stack of paper. Or, as another illustration, when a review group studied the twenty-five most important technology assessments to date for the Second International Congress on Technology Assessment, it had 10,000 pages of reading to do. And even "short" studies are not generally short: one study on earthquakes, acclaimed for its brevity, is 99 pages long. Again much relevant work on arrangement has already been done by rhetoricians and by technical communicators; yet there is clearly still work remaining.

As a final example of the very fundamental and practical sort of work that people in rhetoric and technical communication might do in the area of technology assessments, models and guidelines are yet to be developed. Typically, the technology assessor is not a highly skilled writer, yet he must turn aside from his assessment activities and become a skillful writer if his work is to mean anything. Thus it would be extremely valuable for the assessor/writer to have both models of exceptionally well-done technology assessments (and perhaps negative examples as well) and guidelines for their preparation. Further, it would be especially valuable for the students in technology assessment courses to have such models and guidelines. So far, however, no such set of materials has been developed. It is therefore extremely difficult for those already in the field to answer the obvious question of those new to the field, "How do you know an effective technology assessment when you see one?" It would seem to me that until that question can be answered both in theoretical terms and by example, no valid rhetoric of technology assessment exists.

I have used the field of technology assessment to suggest that important work in rhetoric--in invention and arrangement--needs to be done. However, technology assessment is not the only area one might choose to illustrate that point. Let me therefore mention two other specific areas in which work is also needed.

One area that has interested me for a long time has to do with the use of visuals in scientific and technical communication. Here again there is surprisingly little to go on. Of course if we look at the textbooks with which composition is generally

taught, there is no acknowledgement in most of them that information is ever best communicated visually, a fact which anyone writing or teaching scientific and technical discourse quickly discovers. Thus the 56 percent of our students who go into scientific and technical disciplines, if they have had writing instruction only in Freshman Composition, must discover visual communication for themselves. Indeed it is likely that even if these students take several writing courses in most English departments, and write a good deal as undergraduates, they will receive little experience and virtually no theory on the design and use of visuals. If we look at the technical writing texts there is still a problem. While most books on technical writing have chapters devoted to the design and use of visuals, most neglect very important issues of rhetoric. For example, few texts explore in any thorough or systematic way issues such as, "What types of information are best communicated visually?" "What types of visuals best communicate specific types of information?" "How do you know when a visual aid is needed?" "Where are visuals best placed and how are they best integrated into the text for maximum benefit?" Rather, most texts provide a few examples of visual communication, identify the common pitfalls of such things as distorted scales or faulty labeling of parts, and let it go at that. (I am sorry to say my own text is deficient in this respect.) Yet particularly because today most professionals who are writing in the sciences and technical fields will either have the services of technical illustrators or the help of computer graphics in the implementation of their design choices, it seems somewhat pointless to concentrate as we generally have on mechanical issues. It would be much more helpful to bring to the exploration of this area the same kinds of empirical research skills and same concern for fundamental issues of design that rhetoricians have in the past applied to verbal components.

I might add parenthetically that this exploration of the rhetoric of visual communication in the sciences, engineering, and the professions would require a real effort from people trained, as most of us have been, in English. You might ask yourself, for example, how many times in your entire undergraduate, graduate, and professional career you have written anything that necessarily made extensive use of visuals. My guess is that for most of us the answer would be "very few times." Yet for the writer in scientific and technical disciplines the answer would almost certainly be "all the time." I suspect that it is precisely this lack of need and experience on our part that has caused the rhetoric of visual communication to be as generally neglected as it has been by those working in both rhetoric and technical communication.

As one final example of an area in which basic research and rhetorical theory is needed, let me mention the area of technical manuals, the type of writing which linguists call "task-oriented discourse." Here again there seems to be virtually no rhetoric to go on, even though a great many people in scientific and

technical fields are writing manuals and need help. As an illustration, during the Michigan Engineering Summer Conference course on "Written Communication for Engineers, Scientists, and Technical Writers," a continuing education program for on-the-job professionals, as many as a third of those present come seeking help with manuals of one sort or another. However, the only real help we have been able to give them is essentially editorial. We have not been able successfully to generalize principles by which effective manuals are designed. And I do not believe that we at Michigan are alone in this failure; the available literature does not suggest that others have fully addressed the problem either.

As a consequence of the failure of rhetoricians to develop principles of manual design, the only workable way to tell whether a manual is any good is to try it out, to have someone actually follow the instructions while someone else watches to determine empirically where the trouble spots are. While this procedure certainly works, it is neither efficient nor is it directly helpful to writers of subsequent manuals. It still leaves unanswered, except in an empirical sense, the basic question, "How do you know an effective manual when you see one?" To me as a teacher, and more importantly to scientific and technical people who must write and evaluate manuals, this unanswered question is frustrating. I remember, for example, the late-night despair of the judging committee for the Society of Technical Communication awards competition. When we were trying to decide which of the professionally written manuals in the competition should receive awards for excellence, we kept coming back to the realization that there was no clear way to tell which of the manuals were even good, let alone best. We kept saying, "I *think* this one is good, but I'm not sure why" and we found ourselves searching unconsciously for negative evidence rather than for positive. If that was frustrating for us, think how much more frustrating it must be for someone who has a manual to write and who needs help. Here again there is work to be done.

It should be clear, then, from these three specific instances that there is important and intellectually substantial work to be done in the rhetoric of scientific and technical discourse. Yet if it is clear that important work in rhetoric is to be done, it should also be clear that this work must be done in a systematic manner if it is to be useful. I would like therefore to turn briefly to some suggestions on method.

First, if useful work is to be done in the rhetoric of scientific and technical discourse, it must be done in the manner by which rhetorical theory has always been developed. That is, it must be developed inductively by observers or researchers who go into the places where both effective and ineffective scientific and technical communication are being carried out. It cannot be developed by scholars who are content merely to remain in their offices, to work deductively, and to theorize about how existing rhetorics might be extended to account for changed

communication situations. The measure of effective scientific and technical communication must be of its instrumental effectiveness, not of its comprehensibility in terms of traditional rhetorical theory. This implies that the researcher who is interested in technology assessment, for example, should directly involve himself or herself in the assessment activity to the extent that he or she knows in practical terms which technology assessments have been effective and which not. He or she should approach the area as Aristotle approached the public forum, not with conclusions already reached but with a willingness to be taught. It implies that funded research projects should be proposed.[7] It implies that summer vacations and sabbaticals might be spent not in the library but in a laboratory or in a manufacturing plant. In short, a sound rhetorical theory of scientific and technical discourse can be developed only inductively.

Second, useful work in the rhetoric of science and technology can be done only if researchers are willing to include in their investigations the whole province of rhetoric. They must not concentrate solely upon style but rather must include and even emphasize "pre-writing," or invention, and arrangement. It is clear from the examples I have cited that the problems with much scientific and technical discourse are not to be found in the area that for years has been the focus of much instruction in technical writing and composition--in style. Rather, the problems are to be found at more basic and conceptual levels, in audience analysis and problem definition, for example. Indeed, as someone who has received in my classes technical reports which were formatted, edited, and typed by a computer, I would argue that we are already late in turning our attention from issues of format, style, and mechanics to more fundamental issues. Of course much good work has already been done and it is certainly possible to draw upon existing rhetorics, but there is new work to do nonetheless.

Third, if useful work in the rhetoric of scientific and technical discourse is to be done, that work must be tested by actually trying it out in the field. It cannot adequately be tested on undergraduate students. Rather it must be used by the people for whom the theory was developed, by professionals on the job. At Michigan we are very fortunate to have the Engineering Summer Conference as a place to gather information and to try out rhetorical theory. We also find that the closed-circuit television courses which we offer to subscribing industries in the Detroit area are useful places to experiment. These television courses in technical communication (which, by the way, were the second most frequently requested courses of all of the Engineering School courses offered this year) give us a chance to test what we develop with our ultimate audience, with the people who must use what we teach. If we do not teach what they need or if we teach what will not work, they are quick to let us know it. Consulting work and group work on research projects also provide other opportunities to measure the effectiveness of the theory we develop and teach. Without these tests, I believe, we will have little to offer.

The final point which I would like to suggest is that if useful work is to be done in the rhetoric of scientific and technical discourse it must be undertaken with the understanding that just as scientific and technical disciplines develop and change rapidly, so the communication tools and needs of these disciplines develop and change rapidly. Computer graphics and word processing are still largely unknown among academic people; yet these are tools our students are learning and will use. Similarly, I would guess that almost no one in this room has read the report of a technology assessment; yet this is a kind of cross-disciplinary activity in scientific and technical fields which will no doubt be the focus of the professional lives of many of our students. It is an activity which can fairly be called, as the *New York Times* recently did, "practically a revolution."[8] For these reasons, work in scientific and technical rhetoric must be both on-going and prospective. It can never be truly completed.

I began this paper by saying that I thought those of us in technical writing and in English departments had not kept up with the needs in the rhetoric of science and technology. Instead, I think we have tended to behave like a new generation of scholastics, isolating ourselves from the real concerns of the world in which we live and from what Martin Green, in his article, "The Anti-Humanists," has called, "our supreme intellectual adventure: science."[9] We have tended to look back to traditional rhetoric for our answers. Perhaps it is time, as Green has suggested, that we stop behaving as if the issues of modern science were somebody else's problem. Perhaps it is time that we as humanists began seriously to develop a rhetoric of scientific and technical discourse. Our efforts are clearly needed.

FOOTNOTES

1. Thomas M. Sawyer, "Rhetoric in the Age of Science and Technology," *College Composition and Communication*, December 1972, pp. 390-98.

2. These figures come from two sources: *The Annual Report to the Congress* by the Office of Technology Assessment, March 1976, and Gladwin Hill, "Environmental Impact Statements: Practically a Revolution," *New York Times*, December 5, 1976.

3. One of my colleagues, Professor Dorothy Mack, however, has recently been active in preparing a proposal to NSF for funded research on the communication aspects of technology assessment. She has also attended the Congress on Technology Assessment and conferred with Dr. Joseph Coates, Assistant Director of the Office of Technology Assessment. I am indebted to Prof. Mack for her help in preparing this paper.

4. Joseph Coates, "Technology Assessment: A Tool Kit," *Chemtec*, June 1976, p. 374.

5. Coates, *Ibid.*, p. 372.

6. Problem definition has been worked on in two places particularly: Richard Young, Alton Becker, and Kenneth Pike, *Rhetoric: Discovery and Change* (New York: Harcourt, Brace and World, 1970), Chapter 5. J. C. Mathes and Dwight W. Stevenson, *Designing Technical Reports: Writing for Audiences in Organizations* (Indianapolis: The Bobbs-Merrill Co., Inc., 1976), Chapter 3.

7. At Michigan three of us are preparing a proposal for NSF on technology assessment communication. Another of us has a proposal on value-oriented decision analysis submitted to NSF.

8. Gladwin Hill, "Environmental Impact Statements: Practically a Revolution," *New York Times*, Sunday, December 5, 1976.

9. Martin Green, "The Anti-Humanist Humanists," *Chronicle of Higher Education*, September 20, 1976.